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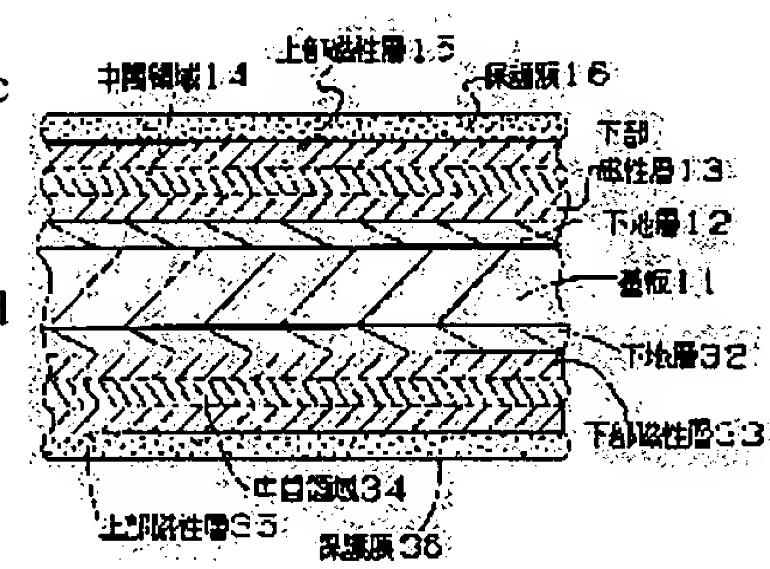
(54) MAGNETIC RECORDING MEDIUM AND MAGNETIC STORAGE DEVICE

(57)Abstract:
PURPOSE: To decrease disk noises at a high recording density by forming Co-Cr- Ta alloy films having a crystalline structure of a hexagonal closed-packed structure as, for example, ferromagnetic layers after formation of nonmagnetic ground layers on a substrate and forming Co-Cr-Ta alloy intermediate regions which have the crystalline structure of likewise the closed-packed hexagonal structure and are mainly paramagnetic on the surfaces of these alloy films, then further forming Co-Cr-Ta magnetic layers which are ferromagnetic thereon.
CONSTITUTION: The metallic ground surface layers 12, 32 consisting of thin films of a Cr system, etc., are provided on the substrate 11 consisting of tempered glass, etc., and the ferromagnetic layers 13, 33 of the Co-Cr-Ta alloy films having the closed-packed hexagonal structure are formed adjacent thereto. The intermediate regions 14, 34 of the Co-Cr-Ta alloys which have the crystalline structure of likewise the closed-packed hexagonal structure and are mainly paramagnetic are formed on the surfaces thereof. Further, the magnetic Co-Cr- Ta layers which are ferromagnetic are formed thereon, by which the disk noises at the high recording density are decreased.



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CLAIMS

[Claim]
[Claim 1] The magnetic-recording medium by which the laminating of a nonmagnetic substratum layer and the thin film alloy magnetic layer which makes cobalt Co a principal component is carried out one by one on a substrate, it is low, and Cr concentration is high, and Co concentration is characterized by the field which is mainly paramagnetic material being by 1 field **** in the orientation of a thickness within this magnetic layer between the fields where Co concentration is high.
[Claim 2] The magnetic-recording medium by which the laminating of a nonmagnetic substratum layer and the thin film alloy magnetic layer which makes Co a principal component is carried out one by one on a substrate, it is low, and Cr concentration is high, and Co concentration is characterized by the field which is mainly paramagnetic material being by two or more fields **** in the orientation of a thickness within this magnetic layer between the fields where Co concentration is high.
[Claim 3] The claim 1 characterized by being in the status in which the field which is the aforementioned paramagnetic material was isolated in the shape of [discontinuous] an island within the film surface, or a magnetic-recording medium given in 2.
[Claim 4] The claim 1 characterized by the aforementioned nonmagnetic substratum layer consisting of a thin film which makes Cr or Cr a principal component, or a magnetic-recording medium given in 3.
[Claim 5] The claim 1 characterized by the values of the residual magnetization Br of the aforementioned magnetic layer and the product of thickness t being below 400G and mum more than 100G and mum, or a magnetic-recording medium given in 4.
[Claim 6] The claim 1 characterized by the values of the residual magnetization Br of the aforementioned magnetic layer and the product of thickness t being below 280G and mum more than 150G and mum, or a magnetic-recording medium given in 4.
[Claim 7] Magnetic storage characterized by writing the magnetic-recording medium of a publication in the claim 1 or 6 with at least one or more sheets and the magnetic head for read-out using the magnetoresistance effect, and coming to combine the inductive head of business.
[Claim 8] Magnetic storage characterized by coming to combine the claim 1 or a magnetic-recording medium given in 5 with at least one or more sheets and an inductive head.

[Translation done.]

DETAILED DESCRIPTION

[Detailed description]
[0001]
[Field of the Invention] this invention relates to the thin film magnetic-recording medium and magnetic storage which were especially excellent in the low noise and the high recording density property about the magnetic storage which used a thin film magnetic-recording medium and this.
[0002]
[Prior art] As a material of the medium in which a high-density record is possible, that by which Co alloy layer was formed on the pure Cr layer, the Co-nickel-Pt system thin film, etc. are proposed, and the part is put in practical use. The Co-Cr-Ta system thin film is used as indicated as a Co alloy magnetic film by eye ********** - and the 122 pages (IEEE Trans. Magn.) of the transaction-on ****** 23rd volume (1987) tex.
[0003] Moreover, a magnetic layer raises a regeneration output further using the thin film medium of multilayer structure, and the motion which is going to attain high recording density-ization also has it (a publication-number 173313 [one to] official report, publication-number 217723 [one to] official report). To be sure by carrying out the laminating of a magnetic layer and the non-magnetic layer, the enhancement in an output can expect with Co base alloy and the Co-Pt alloy containing nickel.
[0004] However, like a publication in a publication-number 283016 [three to] official report, by these mediums, in order the noise and bit shift which are considered to originate in the transition region between the contiguity bits at the time of a record are large and to attain much more high recording density-ization compared with the conventional applied type medium, properties, such as a noise and a bit shift, needed to be raised. From such a background, the magnetic-recording medium which comes to repeat a Co-Cr-Ta system magnetic thin film and Cr system thin film non-magnetic layer by turns is proposed.
[0005] In addition, like [when a Co-Cr-Pt alloy is used as a material of a magnetic layer] a publication (eye ********** - and the 2706 pages (IEEE Trans. Magn.) of the transaction-on ****** 26th volume (1990) tex), when thickness of the magnetic thin film which it comes to repeat by turns is fixed, it is also shown clearly by making the number of nonmagnetic interlayers increase that a noise decreases.
[0006]
[Object of the Invention] However, by the medium by the conventional technique, since it will be necessary to form a nonmagnetic metal interlayer, you have to form much more Cr system thin film nonmagnetic interlayer and the much more magnetic layer further at least after forming a nonmagnetic substratum layer and a magnetic layer. Therefore, the crystallinity of an up magnetic layer fell by formation of the nonmagnetic interlayer from whom the crystal structure is different, and there was a fault that a static magnetism property deteriorated. Moreover, the limitation was in the reduction of the medium noise in high recording density, and the magnetic storage using those mediums had a constraint in large capacity-ization per unit volume.
[0007]
[The means for solving a technical problem] this invention aims at offering high power and the medium of a low noise, without degrading the crystallinity of an up magnetic layer, and a static magnetism property. That is, as a ferromagnetic layer after forming a nonmagnetic substratum layer on a substrate, the crystal structure formed the Co-Cr-Ta alloy layer which takes a hexagonal close packed structure, and similarly the crystal structure took the hexagonal close packed structure on the front face, and mainly formed the further ferromagnetic Co-Cr-Ta magnetic layer in it after forming the Co-Cr-Ta alloy staging area of a paramagnetism. Thus, the crystal structure is the same and this invention is attained by using the staging area of a paramagnetism by removing the non-magnetic metal interlayer process that the conventional crystal structures differed. The staging area of the aforementioned paramagnetism does not necessarily need to be a continuity layer, and even if it is in the status isolated in the shape of [discontinuous] an island in the field, the technical probrem which this invention tends to solve is attained. It is desirable to use the substratum layer which consists of a thin film which makes a principal component a nickel-P thin film, Cr, or Cr as the aforementioned nonmagnetic substratum layer.
[0008] the field whose Co concentration it is a magnetic-recording medium in this invention, and it is low, and Cr concentration is high, and is mainly paramagnetic material within a magnetic layer between the fields where Co concentration is high -- the orientation of a thickness -- 1 field ****, although the medium which carried out the laminating like can also reduce a medium noise compared with the conventional record medium the field whose Co concentration it is low, and Cr concentration is high, and is mainly paramagnetic material between the fields where Co concentration of a magnetic layer is high -- the orientation of a thickness -- two or more fields **** -- the medium which repeated the laminating like has reduced the medium noise further Then, since the magnetic storage which has a magnetic-recording medium using this invention reduced the medium noise in the

magnetic-recording medium, the S/N ratio became good and its performance improved rather than the conventional magnetic storage.
[0009] The magnetic-recording medium using this invention was able to obtain the enhancement in an S/N ratio from the former to the combination with the inductive head used for a record/regeneration to the magnetic head prepared in magnetic storage. Furthermore, it was able to write in with the magnetic head for read-out using the magnetoresistance effect, and the magnetic storage whose S/N ratio improved was able to be obtained also in the combination with record/regeneration discrete-type magnetic head which comes to combine the inductive head of business.
[0010] Moreover, when the value of the residual magnetization Br of the aforementioned magnetic layer [G] and the product of thickness t [mum] uses for a magnetic recording medium the medium which has a value below 400G and mum more than 100G and mum, it can write in with the magnetic head for read-out using the magnetoresistance effect, and the magnetic storage whose S/N ratio improved can be obtained also in the combination with the magnetic-recording medium by which record/regeneration discrete-type magnetic head which comes to combine the inductive head and this invention of business were applied. The direction at the time of using for a magnetic recording medium the medium which furthermore has a value below 280G and mum from the former more than 150G and mum to the inductive head used for a record/regeneration was able to obtain the enhancement in an S/N ratio more.
[0011]
[Operation] this invention person found out that Cr concentration could decrease the medium noise at the time of record regeneration in a 1 field ******** magnetic-recording medium at least in the field which is mainly paramagnetic material highly between magnetic layers. It is thought that this is because a magnetic interaction can be reduced. Therefore, a nonmagnetic substratum layer and the thin film magnetic layer which makes Co a principal component are formed one by one on a substrate. Between the fields where Co concentration in this magnetic layer is high, it is low, and Cr concentration is high, and Co concentration the field which is mainly paramagnetic material in the orientation of a thickness 1 field ******** structure It is very effective in the reduction in the noise of a magnetic-recording medium, and it was thought that it was effective also to the magnetic recording medium which has the magnetic-recording medium which consists of the above-mentioned structure further. Between the fields where Co concentration of a magnetic layer is still high, Co concentration is low, and Cr concentration is high, a magnetic interaction reduces the field which is mainly paramagnetic material in the orientation of a thickness also in two or more fields ******** structure in the orientation of a thickness, the medium noise at the time of record regeneration is reduced much more, and that an effect is in large capacity-ization of a magnetic recording medium also found out. When this effect mainly also forms the layer of a paramagnetism, it is considered because the magnetic interaction between ferromagnetic layers can be reduced.
[0012] In case the field which is mainly paramagnetic material is formed, two kinds of staging areas can mainly be formed by adjusting Cr composition in Co alloy. For example, when a Co-23at.%Cr alloy layer is formed on the thin film formation conditions (1) as [a Co-25at.%Cr alloy layer is paramagnetic material], the layer with which a ferromagnetic and paramagnetic material were intermingled can be formed. Compared with thin film formation conditions (1), the volume ratio of a ferromagnetic with low Cr concentration tended to become higher compared with membranous mean composition by raising substrate temperature or reducing the discharge-gas pressure at the time of thin film formation. It was enabled to reduce the magnetic interaction of the up magnetic substance and the lower magnetic substance by making paramagnetic material and a ferromagnetic live together, or changing the rate through such a staging area that mainly consists of paramagnetic material. the inclination that the rate in which a ferromagnetic exists according to such staging-area formation conditions changes -- Co-Cr -- duality -- it was the same, when it was not limited to a system and the 3rd element of number atom % was added In consideration of the mismatching of a grid, staging-area composition of the composition doubled with the atomic size which the lower magnetic layer averaged can choose.
[0013] On the other hand, when the Co-30at.%Cr alloy layer with high Cr composition was formed on thin film formation conditions (1) compared with Co-25at.%Cr, the layer which consists of a crystalline substance of a paramagnetism and a nonmagnetic amorphous substance was intermingled. Compared with thin film formation conditions (1), by reducing substrate temperature or making the discharge-gas pressure at the time of thin film formation increase For example, "sputtering phenomenon, the University of Tokyo publication meeting, 1984, Kinbara ** work, Although the "self-shadow effect" was produced like a publication in 181 pages" and the amorphous rate increased compared with paramagnetic material, when forming an up magnetic layer, the magnetic interaction of the up magnetic substance and the lower magnetic substance could be reduced by reducing a discharge-gas pressure.
[0014] The ground using the substratum layer which consists of a Cr system thin film as the aforementioned nonmagnetic substratum layer is for carrying out high orientation of the easy axis of the magnetization layer within a field continued and formed on this to field inboard. In case it reproduces using the magnetic head for read-out using the magnetoresistance effect, the values of the residual magnetization Br of the aforementioned magnetic layer [G] and the product of thickness t [mum] of the medium by this invention need to be below 280G and mum more than 150G and mum more preferably below 400G and mum more than 100G and mum. This ground is for obtaining high S/N. When the value of the product of a residual magnetization Br and thickness t carries out to more than 400G and mum, S/N falls. On the other hand, when the values of the product of thickness t and the residual magnetization Br are below 100G and mum, an output will decline.
[0015] In case it reproduces using an inductive head, the values of the residual magnetization Br of the aforementioned magnetic layer [G] and the product of thickness t [mum] of the medium by this invention need to be below 400G and mum more than 300G and mum more preferably below 400G and mum more than 100G and mum. It is based on an output declining that the

values of the residual magnetization Br of the aforementioned magnetic layer [G] and the product of thickness t [mum] are more than 100G and mum, when the values of the product of thickness t and the residual magnetization Br are below 100G and mum.
[0016]
[Example] The following examples explain this invention.
[Example 1] drawing 1 is the cross section showing the magnetic-recording medium in one example of this invention. In drawing 1 11 Substrates, such as tempered glass, plastics, and an aluminium alloy that carried out nickel-P plating, 12 and 32 nickel-P, Cr, Mo and W, Cr-Ti, Cr-Si, Metal-substrate layers, such as Cr-W, and 13 and 33 Co-Cr-nickel, Co-Cr-Ta, Co-Cr-Pt, Co-Cr-Ti, Co-Cr-Zr, Co-Cr-Hf, Lower magnetic layers, such as Co-nickel-Zr, Co-nickel-Ta, and Co-nickel-Cr-Ti, 14 and 34 are compared with the lower magnetic layers 13 and 33. The field where Cr concentration is high in dominance and where Co concentration is low, 36 are a protection layer which consists of 15, up magnetic layer [with 35 / same / as 13 and 33], 16 andC, B, and B4C, Si-C, Co3O4, SiO2, Si3N4, W-C, Zr-W-C, and W-Mo-C-nickel etc. In addition, the diameters of the disk which can attain this invention are disks, such as 10.8, 10.5, 9.5, 6.5, 5.25, 3.5, 2.5, 1.8, and 1.3, 1.0, etc. inches, and especially configurations, such as an outer diameter of a disk, are not limited.
[0017] Aforementioned each class is formed like the example shown below. After giving nickel-12wt.%P plating with a thickness of 20 micrometers to both sides of the aluminium alloy disk substrate 11 which contains magnesium with the diameter of 130mm, a bore [of 40mm], and a thickness of 1.9mm 4%, the slot where the shape of a concentric circle is almost detailed is formed in this plating side. For this reason, center line average side granularity was ground so that it might be set to 10nm, and it ground the nickel-12wt.%P plating thickness so that it might be set to 15 micrometers. if it is the structure where adhesion of a head is avoidable even if the orientation of a slot of a texture is the manipulation which carried out eccentricity not only in the circumferencial direction, although this kind of surface treatment is generally called the texture manipulation, even if it will form a thin film record medium on this substrate -- electromagnetism -- it is satisfactory in any way on the transfer characteristic
[0018] 50nm spatter of the nickel-P which serves as the substratum layers 12 and 32 after washing xeransis in these substrates using the single-wafer-processing **** equipment using DC magnetron cathode was carried out by thickness, 12nm of the Co-15at.%Cr-8at.%Pt layers which serve as the lower magnetic layers 13 and 33 further was formed, and 0.5nm of the Co-20at.%Cr-4at.%Ta alloy staging areas 14 and 34 was formed in this magnetic layer front face. Besides, 12nm of the Co-Cr-Pt layers of the same composition as 13 and 33 was formed as up magnetic layers 15 and 35, and C layer was formed as protection layers 16 and 36. Lubricant, such as a perfluoro alkyl polyether, was made to adhere on this C protective coat.
[0019] As a result of producing the cross-section flake of this disk and observing by the transmission electron microscope, as shown in drawing 2 , staging areas 14 and 34 not necessarily also had not a continuity layer but the island-like fraction, or the separated fraction, and partially, the lower magnetic layers 13 and 33 and the up magnetic layers 15 and 35 touched, and they had the fraction which is carrying out the crystal growth. Therefore, in drawing 1 and drawing 2 , although representation has accomplished like the layer status that staging areas 14 and 34 have the boundary separated clearly, the status that it does not dissociate clearly in the actual invention in this application is also included.
[0020] Protective coat C / magnetic layer (Co-15at.%Cr-8at.%Pt) / substratum layer Cr medium which formed the [example 1 of comparison] magnetic film by the monolayer were formed, and the comparison of [an example 1] and a property was performed.
[0021] The magnetic recording medium with which this invention is applied here is explained using drawing 4 and drawing 5 . Drawing 4 is the schematic diagram of the magnetic recording medium which performs informational record/regeneration to the magnetic disk which is the magnetic-recording medium obtained by this invention, i.e., a magnetic disk unit. Two or more magnetic disks 101 are being fixed to the spindle 105, when a spindle 105 drives, where abbreviation sealing is carried out inside a magnetic disk unit 100, high-speed rotation is carried out, and writing/read-out of a magnetic information are performed by the magnetic head 102. By the rotary actuator 103, the magnetic head 102 positions to the recordable field of a magnetic disk 101. Drawing 5 is a schematic diagram showing the relation of the magnetic disk and the magnetic head to which this invention was applied. The magnetic head 3 shown in drawing 5 is magnetic head which has the head for a record 200, and the head for regeneration 300. The head for a record 200 is an equal in general conventionally with the inductive mold thin film magnetic head used for the purpose of both a record and regeneration. A magnetic circuit can be constituted from a magnetic layer of the up magnetic core 201, the lower magnetic core 204, the magnetic gap 206, and a magnetic-recording medium, and the current which flows in the electric conduction coil 203 can perform record/regeneration to a magnetic disk 207. In this example, it used for records only. The head for regeneration 300 is the magnetoresistance-effect type magnetic head which used the magnetoresistance effect. The head for regeneration 300 which is the magnetoresistance-effect type magnetic head detects resistance change of the magnetoresistance-effect element 303 which changes with change of a magnetic field as a regeneration output. The up shield layer 301 and the lower shield layer 304 intercept the excessive magnetic field to the magnetoresistance-effect element 303 through the nonmagnetic insulator layer 302. Through the nonmagnetic insulating layer 205, on the head slider substrate 305, the laminating of the head for regeneration 300 and the head for a record 200 of the magnetic head 102 in this example is carried out one by one, and they are formed.
[0022] then, the head which applied the magnetic-recording medium formed in [the example 1] and the [example 1 of a comparison] to the above-mentioned **** magnetic disk unit, and used the magnetoresistance effect -- electromagnetism -- the transfer characteristic was evaluated Consequently, the size of the solitary-wave regeneration output of the medium formed in [the example 1 of a comparison] was equivalent to the size of the solitary-wave regeneration output formed in [the example 1]. On the other hand, when a signal was recorded by the same recording density in the medium formed in [the example 1 of a comparison], the disk noise was large 25% compared with the disk noise formed in [the example 1].
[0023] After giving nickel-12wt.%P plating with a thickness of 20 micrometers to both sides of the aluminium alloy disk

substrate 11 which contains magnesium with the [example 2] diameter of 130mm, a bore [of 40mm], and a thickness of 1.27mm 4%, the same texture manipulation as [an example 1] was given.
[0024] This substrate was formed with single-wafer-processing **** equipment after washing xeransis, Cr was formed by 50nm in thickness as substratum layers 12 and 32, further, as lower magnetic layers 13 and 33, 13nm of Co-11at.%Cr-4at.%Ta layers was formed, and 4nm of the Co-21at.%Cr-4at.%Ta staging areas 14 and 34 was formed in this magnetic layer front face. Then, further, as up magnetic layers 15 and 35, 13nm of the Co-11at.%Cr-4at.%Ta layers of the same composition as 13 and 33 was formed, and C layer was formed as protection layers 16 and 36. The thickness of C protection layer could be 30nm. Lubricant, such as a ********** amine, was made to adhere on this C protective coat.
[0025] After giving nickel-12wt.%P plating with a thickness of 20 micrometers to both sides of the aluminium alloy disk substrate 11 which contains magnesium with the [example 2 of comparison] diameter of 130mm, a bore [of 40mm], and a thickness of 1.27mm 4%, the same texture manipulation as an example 1 was given.
[0026] This substrate was formed with single-wafer-processing **** equipment after washing xeransis, Cr was formed by 50nm in thickness as substratum layers 12 and 32, and 4nm of nonmagnetic Cr interlayers was immediately formed by thickness, without a Co-11at.%Cr-4at.%Ta layer oxidizing a front face after 13nm formation as lower magnetic layers 13 and 33 further. Furthermore, continuously, as up magnetic layers 15 and 35, 13nm of the Co-11at.%Cr-4at.%Ta layers of the same composition as 13 and 33 was formed, and C layer was formed as protection layers 16 and 36. The thickness of C protection layer could be 30nm like [the example 2]. Lubricant, such as a ********** amine, was made to adhere on this C protective coat. The value of the coercive force measured with the oscillating-type magnetometer about these cascade screens was decreasing to 1100Oes, when a nonmagnetic Cr staging area was prepared to having been 1460Oes by the cascade screen indicated in [the example 2].
[0027] Thickness formed the alloy (Cr-Ti) substratum layers 12 and 32 like [the example 1] for the [example 3] diameter of 3.5 inches on the glass disk 11 which is 0.8mm. When having formed 20nm of magnetic layers 13 and 33, 4nm of staging areas 14 and 34 was formed for a Co-15at.%Cr-8at.%Pt alloy and 20nm of magnetic layers 15 and 35 was formed for a Co-23at.%Cr-4at%Ta alloy, the Co-10at.%Cr-4at%Ta alloy was used, and also the magnetic-recording medium was formed like the example 1.
[0028] As a magnetic layer given in [the example 3 of a comparison], and the [example 3], prepared 4nm of nonmagnetic Cr interlayers instead of the Co-25at.%Cr-4at%Ta alloy staging area after forming 13 and 33, and magnetic layers 15 and 35 were formed after that, and also the magnetic-recording medium was formed like [the example 3]. The sample of 8mm angle was started from these disks, the theta-2theta scanning was performed by the X-ray diffractometer, and crystallinity was evaluated. Consequently, by the sample produced in [the example 3], compared with the sample which 110 diffraction integrated intensity of Co alloy magnetic layer which takes an hcp structure produced in [the example 3 of a comparison], it was large 1.8 or more times, and it became clear that the crystallinity of an up magnetic layer is also improvable by using the staging area which takes the same crystal structure as a ferromagnetic.
[0029] [Example 4] drawing 3 is the cross section of the magnetic-recording medium in other examples of the invention in this application. As shown in drawing 3 , in-line spatter equipment is used. on the glassy-carbon substrate 11 by the DC magnetron ~~spatter method The~~ Co-23at.%Cr-2at.%Ta layer with a thickness of 0.5nm was continuously formed for the Co-12at.%Cr-2at.%Ta layer with a thickness of 9nm as staging areas 14 and 34 after formation as Cr substratum layers 12 and 32 with a thickness of 50nm and lower magnetic films 13 and 33.
[0030] As magnetic layers 24 and 25 of the still same thickness as the lower magnetic layers 13 and 33, then, a Co-12at.%Cr-2at.%Ta layer, As staging areas 14 and 34, the Co-12at.%Cr-2at.%Ta layer was formed after forming a Co-23at.%Cr-2at.%Ta layer ~~with a thickness of 0.5nm as up magnetic layers 15 and 35 of the still same thickness as the lower magnetic layers 13 and~~ 33, and C layer was formed as protective coats 16 and 36.
[0031] and also it changed the thickness of a medium so that the value of the thickness of the magnetic layer used for the medium given in [an example 5] and the [example 1] and the product of a residual magnetization might take the value of 360G and mum -- [an example 1] -- the same -- carrying out -- an inductive head -- using -- electromagnetism -- the transfer characteristic was evaluated With the magnetic disk unit shown in drawing 4 , and the same equipment, the regeneration section in the magnetic head 102 used the magnetic head of an inductive mold. Consequently, although the solitary-wave regeneration output did not change compared with the case where a magnetic layer is formed as a monolayer in the medium given in this example, when a signal was recorded by the same recording density, the disk noise was reduced about 22%.
[0032] As this magnetic-recording medium was shown in drawing 5 , the high-density magnetic recording of 70 or more kFCIs was realizable by using the magnetic head which combined the magnetoresistance-effect type magnetic head and the inductive mold magnetic head.
[0033] By using the magnetic-recording medium in the example of above some, the magnetic recording medium of high recording density can be obtained compared with the magnetic-recording medium which has the conventional multilayer.
[0034]
[Effect of the invention] A reduction of the disk noise in high recording density is enabled, without degrading a static magnetism property and crystallinity. Moreover, S/N was able to offer good mass magnetic storage using the magnetic-recording medium of this invention.

[Translation done.]

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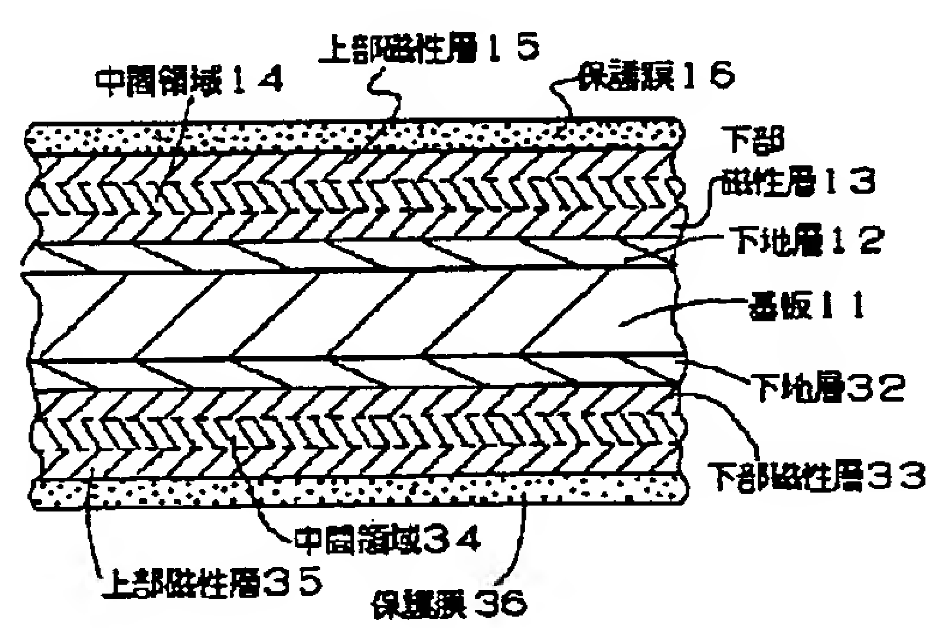
(54) **MAGNETIC RECORDING MEDIUM AND MAGNETIC STORAGE DEVICE**

(57) Abstract:

PURPOSE: To decrease disk noises at a high recording density by forming Co-Cr- Ta alloy films having a crystalline structure of a hexagonal closed-packed structure as, for example, ferromagnetic layers after formation of nonmagnetic ground layers on a substrate and forming Co-Cr-Ta alloy intermediate regions which have the crystalline structure of likewise the closed-packed hexagonal structure and are mainly paramagnetic on the surfaces of these alloy films, then further forming Co-Cr-Ta magnetic layers which are ferromagnetic thereon.

CONSTITUTION: The metallic ground surface layers 12, 32 consisting of thin films of a Cr system, etc., are provided on the substrate 11 consisting of tempered glass, etc., and the ferromagnetic layers 13, 33 of the Co-Cr-Ta alloy films having the closed-packed hexagonal structure are formed adjacent thereto. The intermediate regions 14, 34 of the Co-Cr-Ta alloys which have the crystalline structure of likewise the closed-packed hexagonal structure and are mainly paramagnetic are formed on the surfaces thereof. Further, the magnetic Co-Cr- Ta layers which are ferromagnetic are formed thereon, by which the disk noises at the high recording density are decreased.



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最終頁に続く

(54)【発明の名称】　磁気記録媒体及び磁気記憶装置

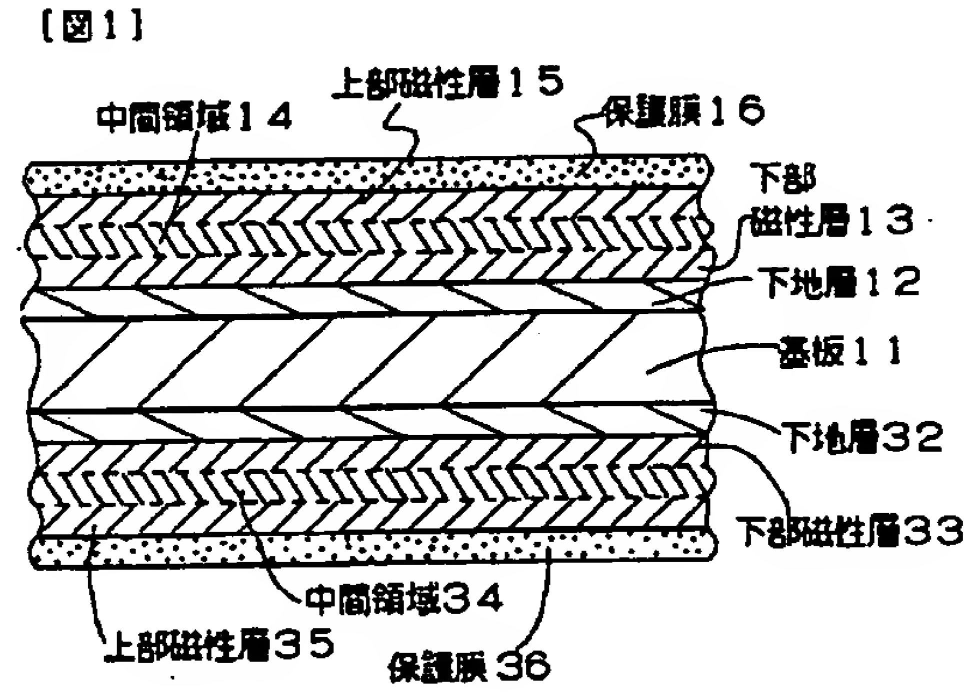
(57)【要約】

【目的】　ディスクノイズを低減した磁気記録媒体を提供すること。

【構成】　磁気的な相互作用を低減可能な中間領域として主として常磁性体のCr濃度の高い領域を膜厚方向に少なくとも一領域形成したことを特徴とする磁気記録媒体。

【効果】　高記録密度の磁気記録装置を得ることができる。

【図1】



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【特許請求の範囲】

【請求項1】　基板上に、非磁性下地層、コバルトＣｏを主成分とする薄膜合金磁性層が順次積層され、該磁性層内でＣｏ濃度の高い領域間にＣｏ濃度が低くかつＣｒ濃度が高く主として常磁性体である領域を膜厚方向に一領域含んでいることを特徴とする磁気記録媒体。

【請求項2】　基板上に、非磁性下地層、Ｃｏを主成分とする薄膜合金磁性層が順次積層され、該磁性層内でＣｏ濃度の高い領域間にＣｏ濃度が低くかつＣｒ濃度が高く主として常磁性体である領域を膜厚方向に複数領域含んでいることを特徴とする磁気記録媒体。

【請求項3】　前記常磁性体である領域が膜面内で不連続な島状に孤立した状態であることを特徴とする請求項１乃至２に記載の磁気記録媒体。

【請求項4】　前記非磁性下地層がＣｒあるいはＣｒを主成分とする薄膜からなることを特徴とする請求項１乃至３に記載の磁気記録媒体。

【請求項5】　前記磁性層の残留磁化Ｂｒと膜厚ｔの積の値が１００Ｇ・μm以上４００Ｇ・μm以下であることを特徴とする請求項１乃至４に記載の磁気記録媒体。

【請求項6】　前記磁性層の残留磁化Ｂｒと膜厚ｔの積の値が１５０Ｇ・μm以上２８０Ｇ・μm以下であることを特徴とする請求項１乃至４に記載の磁気記録媒体。

【請求項7】　請求項１乃至６に記載の磁気記録媒体を少なくとも１枚以上と、磁気抵抗効果を用いた読み出し用磁気ヘッドと書き込み用のインダクティブヘッドを組み合わせてなることを特徴とする磁気記憶装置。

【請求項8】　請求項１乃至５に記載の磁気記録媒体を少なくとも１枚以上と、インダクティブヘッドと組み合わせてなることを特徴とする磁気記憶装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は薄膜磁気記録媒体及びこれを用いた磁気記憶装置に関し、特に低ノイズかつ高記録密度特性に優れた薄膜磁気記録媒体及び磁気記憶装置に関する。

【０００２】

【従来の技術】高密度な記録が可能な媒体の材料として、純Ｃｒ膜上にＣｏ合金膜が形成されたものや、Ｃｏ－Ｎｉ－Ｐｔ系薄膜などが提案されており、一部実用化されている。Ｃｏ合金磁性膜としては例えばアイトリプルイー・トランザクション・オン・マグネティックス（ＩＥＥＥ　Ｔｒａｎｓ．　Ｍａｇｎ．）第２３巻（１９８７年）１２２ページに記載されているようにＣｏ－Ｃｒ－Ｔａ系薄膜が用いられている。

【０００３】また、磁性層が多層構造の薄膜媒体を用いて再生出力を更に向上させ、高記録密度化を達成しようとする動きもある（特開平１－１７３３１３号公報、特開平１－２１７７２３号公報）。磁性層と非磁性層を積層することにより、Ｎｉを含有したＣｏ基合金、Ｃｏ－Ｐｔ合金等では出力向上が確かに期待できる。

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【０００４】しかしながら、特開平３－２８３０１６号公報に記載のように、これらの媒体では記録時の隣接ビット間の遷移領域に由来すると考えられるノイズやビットシフトが従来の塗布型媒体に比べ大きく、より一層の高記録密度化を達成するためにはノイズおよびビットシフト等の特性を向上させる必要があった。このような背景から、Ｃｏ－Ｃｒ－Ｔａ系磁性薄膜とＣｒ系薄膜非磁性層を交互に繰り返してなる磁気記録媒体が提案されている。

【０００５】このほか、磁性層の材料としてＣｏ－Ｃｒ－Ｐｔ合金を用いた場合には、アイトリプルイー・トランザクション・オン・マグネティックス(ＩＥＥＥ　Ｔｒａｎｓ．　Ｍａｇｎ．)第２６巻(１９９０年)２７０６ページに記載のように、交互に繰り返してなる磁性薄膜の厚さを一定にした場合には、非磁性中間層の数を増加させることにより、ノイズが減少することも明らかにされている。

【０００６】

【発明が解決しようとする課題】しかしながら、従来技術による媒体では、非磁性の金属中間層を形成する必要が生じるために、非磁性下地層と磁性層を形成後、さらに少なくとも一層のＣｒ系薄膜非磁性中間層と磁性層を形成しなければならない。従って、結晶構造の異なった非磁性中間層の形成により上部磁性層の結晶性が低下し、静磁気特性が劣化するという欠点があった。また高記録密度における媒体ノイズの低減に限界があり、それらの媒体を用いた磁気記憶装置は、単位体積あたりの大容量化に制約があった。

【０００７】

【課題を解決するための手段】本発明は、上部磁性層の結晶性、静磁気特性を劣化させること無く、高出力かつ低ノイズの媒体を提供することを目的とする。すなわち、基板上に非磁性下地層を形成後、例えば強磁性層として結晶構造が稠密六方構造をとるＣｏ－Ｃｒ－Ｔａ合金膜を形成し、その表面に結晶構造が同じく稠密六方構造をとり、主として常磁性のＣｏ－Ｃｒ－Ｔａ合金中間領域を形成後、更に強磁性のＣｏ－Ｃｒ－Ｔａ磁性層を形成した。このように結晶構造が同じで常磁性の中間領域を用いることにより、従来の結晶構造の異なった非磁性金属中間層プロセスを除くことにより本発明は達成される。前記常磁性の中間領域は、必ずしも連続膜である必要はなく、面内で不連続な島状に孤立した状態であっても、本発明が解決しようとする課題は達成される。前記非磁性下地層としては、Ｎｉ-Ｐ薄膜、Ｃｒ、あるいはＣｒを主成分とする薄膜からなる下地層を用いることが好ましい。

【０００８】本発明における磁気記録媒体であって、磁性層内でＣｏ濃度の高い領域間にＣｏ濃度が低くかつＣｒ濃度が高く主として常磁性体である領域を膜厚方向に

一領域含むように積層した媒体も、従来の記録媒体に比べ媒体ノイズを低減できるが、磁性層のＣｏ濃度の高い領域間にＣｏ濃度が低く、かつ、Ｃｒ濃度が高く主として常磁性体である領域を、膜厚方向に複数領域含むように積層を繰り返した媒体は、媒体ノイズをさらに低減できた。そこで本発明を用いた磁気記録媒体を有する磁気記憶装置は、磁気記録媒体において媒体ノイズが低減できたため、Ｓ／Ｎ比が良好になり従来の磁気記憶装置よりも性能が向上した。

【０００９】磁気記憶装置に設けられた磁気ヘッドに対して本発明を用いた磁気記録媒体は、従来から記録／再生に用いているインダクティブヘッドとの組合せに対して、Ｓ／Ｎ比の向上を得ることができた。さらに、磁気抵抗効果を用いた読み出し用磁気ヘッドと書き込み用のインダクティブヘッドを組み合わせてなる記録／再生分離型磁気ヘッドとの組合せでも、Ｓ／Ｎ比が向上した磁気記憶装置を得ることができた。

【００１０】また前記磁性層の残留磁化Ｂｒ［Ｇ］と膜厚ｔ［μｍ］の積の値が100G・μm以上400G・μm以下の値を有する媒体を磁気記録装置に用いた場合、磁気抵抗効果を用いた読み出し用磁気ヘッドと書き込み用のインダクティブヘッドを組み合わせてなる記録／再生分離型磁気ヘッドと本発明が適用された磁気記録媒体との組合せでも、Ｓ／Ｎ比が向上した磁気記憶装置を得ることができる。さらに従来から記録／再生に用いているインダクティブヘッドに対しては、１５０Ｇ・μｍ以上２８０Ｇ・μｍ以下の値を有する媒体を磁気記録装置に用いた場合の方が、よりＳ／Ｎ比の向上を得ることができた。

【００１１】

【作用】本発明者は、磁性層間にＣｒ濃度が高く主として常磁性体である領域を少なくとも一領域含ませた磁気記録媒体において、記録再生時の媒体ノイズを減少できることを見出した。これは、磁気的相互作用を低減できるためであると考えられる。したがって、基板上に、非磁性下地層、Ｃｏを主成分とする薄膜磁性層が順次形成され、該磁性層内のＣｏ濃度の高い領域間でＣｏ濃度が低くかつＣｒ濃度が高く主として常磁性体である領域を膜厚方向で一領域含ませる構造は、磁気記録媒体の低ノイズ化に非常に有効であり、さらに上記構造から成る磁気記録媒体を有する磁気記録装置に対しても有効であると考えた。さらに磁性層のＣｏ濃度の高い領域間にＣｏ濃度が低くかつＣｒ濃度が高く、主として常磁性体である領域を膜厚方向に複数領域含ませた構造においても、膜厚方向に磁気的相互作用が低減し、記録再生時の媒体ノイズは一層低減され、磁気記録装置の大容量化に効果があることも見出した。この効果も主として常磁性の層を形成することにより強磁性層間の磁気的相互作用を低減できるためと考えられる。

【００１２】主として常磁性体である領域を形成する際に、Ｃｏ合金中のＣｒ組成を調整することにより、主として２種類の中間領域が形成可能である。例えばＣｏ－２５ａｔ．％Ｃｒ合金膜が常磁性体であるような薄膜形成条件（１）でＣｏ－２３ａｔ．％Ｃｒ合金膜を形成した場合、強磁性体と常磁性体が混在した膜が形成可能である。薄膜形成条件（１）に比べ、基板温度を上昇させたり、薄膜形成時の放電ガス圧力を低下させたりすることにより、膜の平均組成に比べＣｒ濃度の低い強磁性体の体積比は、より高くなる傾向があった。このような、主として常磁性体からなる中間領域を介して、例えば常磁性体と強磁性体とを共存させ、あるいはその割合を変化させることにより、上部磁性体と下部磁性体の磁気的相互作用を低減することが可能になった。このような中間領域形成条件によって強磁性体の存在する割合が変化する傾向は、Ｃｏ－Ｃｒ二元系に限定されたものではなく数原子％の第３元素を添加した場合にも同様であった。格子の不整合を考慮し、下部磁性層の平均した原子サイズに合わせた組成の中間領域組成が選択しうる。

【００１３】一方、Ｃｏ－２５ａｔ．％Ｃｒに比べＣｒ組成の高いＣｏ－３０ａｔ．％Ｃｒ合金膜を薄膜形成条件（１）で形成した場合には、常磁性の結晶質と非磁性の非晶質からなる膜が混在していた。薄膜形成条件（１）に比べ、基板温度を低下させたり、薄膜形成時の放電ガス圧力を増加させたりすることにより、例えば「スパッタリング現象、東京大学出版会、１９８４年、金原 粲 著、１８１頁」に記載のように「自己陰影効果」を生じ、常磁性体に比べ非晶質の割合が多くなるものの、上部磁性層を形成する際に放電ガス圧力を低下させることにより、上部磁性体と下部磁性体の磁気的相互作用を低減できるようになった。

【００１４】前記非磁性下地層としてＣｒ系薄膜からなる下地層を用いる理由は、この上に連続して形成する面内磁化膜の磁化容易軸を面内方向に高配向させるためである。 磁気抵抗効果を用いた読み出し用磁気ヘッドを用いて再生を行なう際に、本発明による媒体は前記磁性層の残留磁化Ｂｒ［Ｇ］と膜厚ｔ［μｍ］の積の値が１００Ｇ・μｍ以上４００Ｇ・μｍ以下、より好ましくは１５０Ｇ・μｍ以上２８０Ｇ・μｍ以下である必要がある。この理由は、高いＳ／Ｎを得るためである。残留磁化Ｂｒと膜厚ｔの積の値が４００Ｇ・μｍ以上とした場合には、Ｓ／Ｎが低下する。一方、膜厚ｔと残留磁化Ｂｒの積の値が１００Ｇ・μｍ以下の場合には、出力が低下してしまう。

【００１５】インダクティブヘッドを用いて再生を行なう際に、本発明による媒体は前記磁性層の残留磁化Ｂｒ［Ｇ］と膜厚ｔ［μｍ］の積の値が１００Ｇ・μｍ以上４００Ｇ・μｍ以下、より好ましくは３００Ｇ・μｍ以上４００Ｇ・μｍ以下である必要がある。前記磁性層の残留磁化Ｂｒ［Ｇ］と膜厚ｔ［μｍ］の積の値が１００Ｇ・μｍ以上であるのは膜厚ｔと残留磁化Ｂｒの積の値

が１００Ｇ・μm以下の場合には、出力が低下してしまうことによる。

【００１６】

【実施例】本発明を以下の実施例により説明する。

〔実施例１〕図１は、本発明の一実施例における磁気記録媒体を示す断面図である。図１において、１１は強化ガラス、プラスチック、Ｎｉ－Ｐメッキしたアルミニウム合金等の基板、１２、３２はＮｉ－Ｐ、Ｃｒ、Ｍｏ、Ｗ、Ｃｒ－Ｔｉ、Ｃｒ－Ｓｉ、Ｃｒ－Ｗなどの金属下地層、１３、３３はＣｏ－Ｃｒ－Ｎｉ、Ｃｏ－Ｃｒ－Ｔａ、Ｃｏ－Ｃｒ－Ｐｔ、Ｃｏ－Ｃｒ－Ｔｉ、Ｃｏ－Ｃｒ－Ｚｒ、Ｃｏ－Ｃｒ－Ｈｆ、Ｃｏ－Ｎｉ－Ｚｒ、Ｃｏ－Ｎｉ－Ｔａ、Ｃｏ－Ｎｉ－Ｃｒ－Ｔｉ等の下部磁性層、１４、３４は下部磁性層１３、３３に比べ優位的にＣｒ濃度が高くＣｏ濃度が低い領域、１５、３５は１３、３３と同様な上部磁性層、１６、３６はＣ、Ｂ、Ｂ４Ｃ、Ｓｉ－Ｃ、Ｃｏ３Ｏ４、ＳｉＯ２、Ｓｉ３Ｎ４、Ｗ－Ｃ、Ｚｒ－Ｗ－Ｃ、Ｗ－Ｍｏ－Ｃ－Ｎｉ等からなる保護層である。なお、本発明が達成できる円板の直径は、例えば１０．８、１０．５、９．５、６．５、５．２５、３．５、２．５、１．８、１．３、１．０インチ等の円板であり、特に円板の外径等の形状は限定されない。

【００１７】前記の各層は、たとえば以下に示す例のように形成される。直径１３０mm、内径４０mm、厚さ１．９mmのマグネシウムを４％含むアルミニウム合金ディスク基板１１の両面に厚さ２０μmのＮｉ－１２ｗｔ．％Ｐメッキを施した後、このメッキ面にほぼ同心円状の微細な溝を形成する。このために中心線平均面粗さは１０ｎmになるように研磨して、Ｎｉ－１２ｗｔ．％Ｐメッキ膜厚を１５μmとなるように研磨した。この種の表面加工を一般にテクスチャー加工と称しているが、テクスチャーの溝方向は、円周方向だけではなく、偏心した加工であっても、ヘッドの粘着を回避できる構造であればこの基板上に薄膜記録媒体を形成しても電磁変換特性上何ら問題はない。

【００１８】これらの基板を洗浄乾燥後、ＤＣマグネトロンカソードを用いた枚葉式成膜装置を用いて、下地層１２、３２となるＮｉ－Ｐを厚さで５０ｎｍスパッタし、さらに下部磁性層１３、３３となるＣｏ－１５ａｔ．％Ｃｒ－８ａｔ．％Ｐｔ膜を１２ｎｍ形成し、この磁性層表面にＣｏ－２０ａｔ．％Ｃｒ－４ａｔ．％Ｔａ合金中間領域１４、３４を０．５ｎｍ形成した。この上に上部磁性層１５、３５として１３、３３と同一組成のＣｏ－Ｃｒ－Ｐｔ膜を１２ｎｍ形成し、保護層１６、３６としてＣ膜を形成した。このＣ保護膜上には、パーフルオロアルキルポリエーテル等の潤滑剤を付着させた。

【００１９】この円板の断面薄片を作製し、透過電子顕微鏡で観察した結果、図２に示すように中間領域１４、３４は必ずしも連続膜ではなく、島状の部分、或いは分離した部分もあり、部分的に下部磁性層１３、３３と上部磁性層１５、３５が接して結晶成長している部分があった。したがって、図１、図２において、中間領域１４、３４が、あたかも明確に分離された境界を有する層状態のように表現が成されているが、実際の本願発明においては明確に分離されていない状態をも含まれる。

【００２０】〔比較例１〕磁性膜を単層で形成した保護膜Ｃ／磁性層（Ｃｏ－１５ａｔ．％Ｃｒ－８ａｔ．％Ｐｔ）／下地層Ｃｒ媒体を形成し、〔実施例１〕と特性の比較を行った。

【００２１】ここで本発明が適用される磁気記録装置について図４及び図５を用いて説明する。図４は、本発明によって得られる磁気記録媒体である磁気ディスクに、情報の記録／再生を行う磁気記録装置、即ち磁気ディスク装置の概略図である。磁気ディスク１０１はスピンドル１０５に複数枚固定されており、スピンドル１０５が駆動することによって磁気ディスク装置１００の内部に略密閉された状態で高速回転をし、磁気ヘッド１０２によって磁気情報の書き込み／読み出しが行われる。磁気ヘッド１０２はロータリーアクチュエータ１０３によって、磁気ディスク１０１の記録可能領域に位置決めを行う。図５は、本発明が適用された磁気ディスクと磁気ヘッドとの関係を表す概略図である。図５に示した磁気ヘッド３は、記録用ヘッド２００と、再生用ヘッド３００とを有する磁気ヘッドである。記録用ヘッド２００は、従来、記録及び再生の両方の目的に使用されてきたインダクティブ型薄膜磁気ヘッドと概ね等しいものである。上部磁気コア２０１と下部磁気コア２０４と磁気ギャップ２０６、及び磁気記録媒体の磁性層とで磁気回路を構成し、導電コイル２０３に流れる電流により磁気ディスク２０７へ記録／再生を行うことができる。本実施例においては記録専用に用いた。再生用ヘッド３００は、磁気抵抗効果を用いた磁気抵抗効果型磁気ヘッドである。磁気抵抗効果型磁気ヘッドである再生用ヘッド３００は、磁界の変化によって変化する磁気抵抗効果素子３０３の抵抗変化を再生出力として検出する。上部シールド膜３０１及び下部シールド膜３０４は、非磁性絶縁膜３０２を介して磁気抵抗効果素子３０３への余分な磁界を遮断する。本実施例における磁気ヘッド１０２の再生用ヘッド３００及び記録用ヘッド２００は、非磁性絶縁層２０５を介してヘッドスライダ基板３０５上に順次積層されて形成する。

【００２２】そこで〔実施例１〕、〔比較例１〕において形成した磁気記録媒体を、上記の如き磁気ディスク装置に適用し、磁気抵抗効果を利用したヘッドにより電磁変換特性を評価した。その結果、〔比較例１〕で形成した媒体の孤立波再生出力の大きさは、〔実施例１〕で形成した孤立波再生出力の大きさと同等であった。一方、〔比較例１〕で形成した媒体において同じ記録密度で信号を記録した場合、ディスクノイズは、〔実施例１〕で形成したディスクノイズに比べ２５％大きかった。

【００２３】〔実施例２〕直径１３０ｍｍ、内径４０ｍｍ、厚さ１．２７ｍｍのマグネシウムを４％含むアルミニウム合金ディスク基板１１の両面に厚さ２０μｍのＮｉ－１２ｗｔ．％Ｐメッキを施した後、〔実施例１〕と同様なテクスチャー加工を施した。

【００２４】この基板を洗浄乾燥後、枚葉式成膜装置で下地層１２、３２としてＣｒを厚さ５０ｎｍで形成し、さらに下部磁性層１３、３３としてＣｏ－１１ａｔ．％Ｃｒ－４ａｔ．％Ｔａ膜を１３ｎｍ形成し、この磁性層表面にＣｏ－２１ａｔ．％Ｃｒ－４ａｔ．％Ｔａ中間領域１４、３４を４ｎｍ形成した。この後、さらに上部磁性層１５、３５として１３、３３と同一組成のＣｏ－１１ａｔ．％Ｃｒ－４ａｔ．％Ｔａ膜を１３ｎｍ形成し、保護層１６、３６としてＣ膜を形成した。Ｃ保護層の膜厚は３０ｎｍとした。このＣ保護膜上にフェニキシアミン等の潤滑剤を付着させた。

【００２５】〔比較例２〕直径１３０ｍｍ、内径４０ｍｍ、厚さ１．２７ｍｍのマグネシウムを４％含むアルミニウム合金ディスク基板１１の両面に厚さ２０μｍのＮｉ－１２ｗｔ．％Ｐメッキを施した後、実施例１と同様なテクスチャー加工を施した。

【００２６】この基板を洗浄乾燥後、枚葉式成膜装置で下地層１２、３２としてＣｒを厚さ５０ｎｍで形成し、さらに下部磁性層１３、３３としてＣｏ－１１ａｔ．％Ｃｒ－４ａｔ．％Ｔａ膜を１３ｎｍ形成後、表面を酸化させること無くただちに非磁性Ｃｒ中間層を厚みで４ｎｍ形成した。さらに連続して上部磁性層１５、３５として１３、３３と同一組成のＣｏ－１１ａｔ．％Ｃｒ－４ａｔ．％Ｔａ膜を１３ｎｍ形成し、保護層１６、３６としてＣ膜を形成した。Ｃ保護層の膜厚は〔実施例２〕と同様に３０ｎｍとした。このＣ保護膜上にフェニキシアミン等の潤滑剤を付着させた。これらの積層膜について、振動式磁力計により測定した保磁力の値は、〔実施例２〕に記載した積層膜で１４６０Ｏｅであったのに対し、非磁性Ｃｒ中間領域を設けた場合には１１００Ｏｅまで減少していた。

【００２７】〔実施例３〕直径３．５インチで厚みが０．８ｍｍのガラス円板１１上に〔実施例１〕と同様にして（Ｃｒ－Ｔｉ）合金下地層１２、３２を形成した。磁性層１３、３３を２０ｎｍ形成する際にＣｏ－１５ａｔ．％Ｃｒ－８ａｔ．％Ｐｔ合金を、中間領域１４、３４を４ｎｍ形成する際にＣｏ－２３ａｔ．％Ｃｒ－４ａｔ％Ｔａ合金を、磁性層１５、３５を２０ｎｍ形成する際にＣｏ－１０ａｔ．％Ｃｒ－４ａｔ％Ｔａ合金を用いた他は、実施例１と同様にして磁気記録媒体を形成した。

【００２８】〔比較例３〕〔実施例３〕に記載の磁性層として１３、３３を形成後、Ｃｏ－２５ａｔ．％Ｃｒ－４ａｔ％Ｔａ合金中間領域のかわりに非磁性Ｃｒ中間層を４ｎｍ設け、その後磁性層１５、３５を形成した他は、〔実施例３〕と同様にして磁気記録媒体を形成した。これらの円板から８ｍｍ角の試料を切り出し、Ｘ線ディフラクトメータでθ－２θ走査を行ない、結晶性を評価した。その結果、〔実施例３〕で作製した試料ではｈｃｐ構造をとるＣｏ合金磁性層の１１０回折積分強度が〔比較例３〕で作製した試料に比べ１．８倍以上大きく、強磁性体と同じ結晶構造をとる中間領域を用いることにより上部磁性層の結晶性も改善できることが明らかになった。

【００２９】〔実施例４〕図３は、本願発明の他の実施例における磁気記録媒体の断面図である。図３に示すように、インラインスパッタ装置を用いて、グラッシーカーボン基板１１上にＤＣマグネトロンスパッタ法で、厚さ５０ｎｍのＣｒ下地膜１２、３２、下部磁性膜１３、３３として厚さ９ｎｍのＣｏ－１２ａｔ．％Ｃｒ－２ａｔ．％Ｔａ膜を連続して形成後、中間領域１４、３４として厚さ０．５ｎｍのＣｏ－２３ａｔ．％Ｃｒ－２ａｔ．％Ｔａ膜を形成した。

【００３０】その後、さらに下部磁性層１３、３３と同じ厚さの磁性層２４、２５としてＣｏ－１２ａｔ．％Ｃｒ－２ａｔ．％Ｔａ膜、中間領域１４、３４として厚さ０．５ｎｍのＣｏ－２３ａｔ．％Ｃｒ－２ａｔ．％Ｔａ膜を形成後、さらに下部磁性層１３、３３と同じ厚さの上部磁性層１５、３５としてＣｏ－１２ａｔ．％Ｃｒ－２ａｔ．％Ｔａ膜、保護膜１６、３６としてＣ膜を形成した。

【００３１】〔実施例５〕〔実施例１〕に記載の媒体に用いた磁性層の膜厚と残留磁化の積の値が３６０Ｇ・μｍの値をとるように媒体の膜厚を変更した他は、〔実施例１〕と同様にしてインダクティブヘッドを用いて電磁変換特性を評価した。図４に示した磁気ディスク装置と同様の装置で、磁気ヘッド１０２における再生部がインダクティブ型の磁気ヘッドを用いた。その結果、磁性層を単層膜として形成した場合に比べ、本実施例に記載の媒体は孤立波再生出力は変化しないが、同じ記録密度で信号を記録した場合、ディスクノイズは約２２％低減した。

【００３２】この磁気記録媒体を、図５に示した如く、磁気抵抗効果型磁気ヘッドとインダクティブ型磁気ヘッドを組み合わせた磁気ヘッドを用いることにより、７０ｋＦＣＩ以上の高密度磁気記録が実現できた。

【００３３】以上いくつかの実施例における磁気記録媒体を用いることによって、従来の多層膜を有する磁気記録媒体に比べて、高記録密度の磁気記録装置を得ることができる。

【００３４】

【発明の効果】静磁気特性、結晶性を劣化させることなく高記録密度におけるディスクノイズを低減可能とする。また、本発明の磁気記録媒体を用いて、Ｓ／Ｎが良好な大容量磁気記憶装置を提供することができた。

【図面の簡単な説明】

【図１】本発明の一実施例の磁気記録媒体の断面図

【図２】本発明の他の実施例の磁気記録媒体の断面図

【図３】本発明の他の実施例の磁気記録媒体の断面図

【図４】本発明が適用された磁気記録媒体を用いる磁気記憶装置の概略図

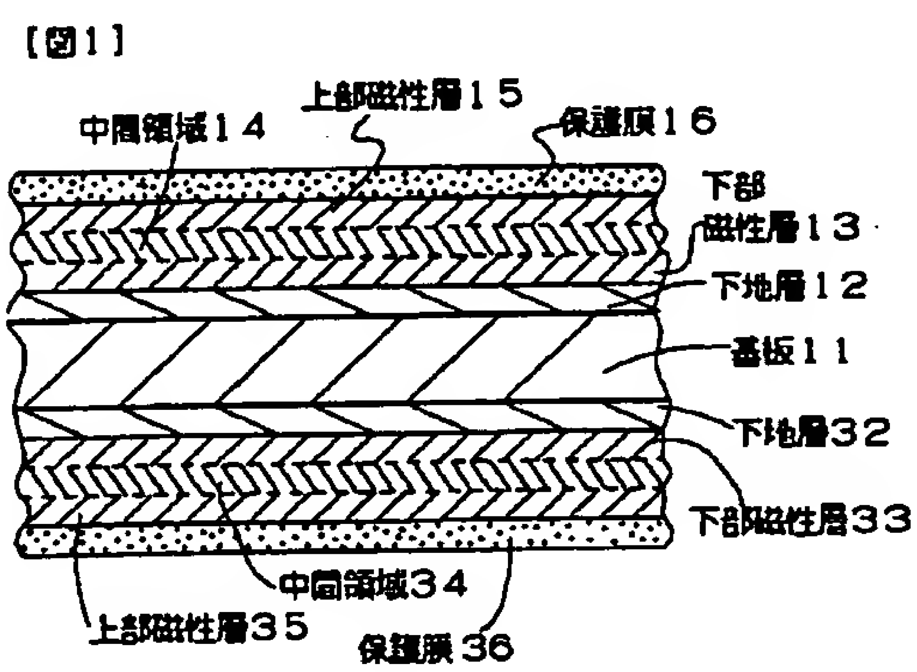
【図５】本発明が適用された磁気記録媒体と磁気ヘッドとの関係を表す概略図

【符号の説明】

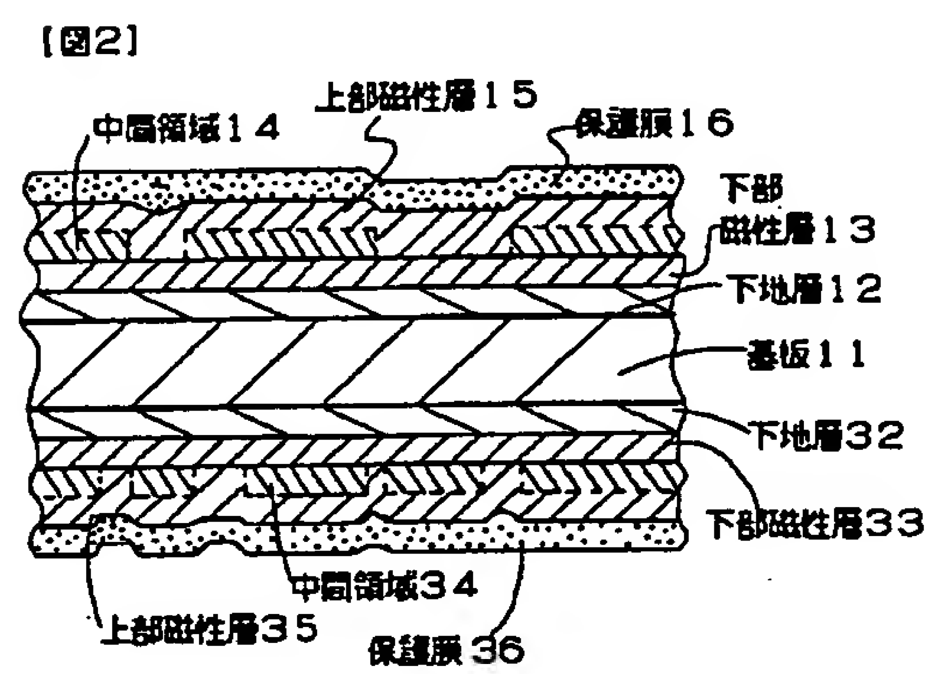
１１：基板、１２及び３２：金属下地層、１３及び３３：下部磁性層、１４、２４、３４及び４４：１３、３３に比べ優位的にＣｒ濃度が高い中間領域、１５及び３

５：上部磁性層、１６及び３６：保護層、２５及び４５：磁性層、１００：磁気記憶装置、１０１：磁気ディスク、１０２：磁気ヘッド、１０３：ロータリーアクチュエータ、１０４：スピンドル、２００：記録用ヘッド、２０１：上部磁気コア、２０２：非磁性絶縁層、２０３：導体コイル、２０４：下部磁気コア、２０５：非磁性絶縁層、２０６：磁気ギャップ、２０７：磁気記録媒体、３００：再生用ヘッド、３０１：上部シールド膜、３０２：非磁性絶縁膜、３０３：磁気抵抗効果素子、３０４：下部シールド膜、３０５：ヘッドスライダ基板、

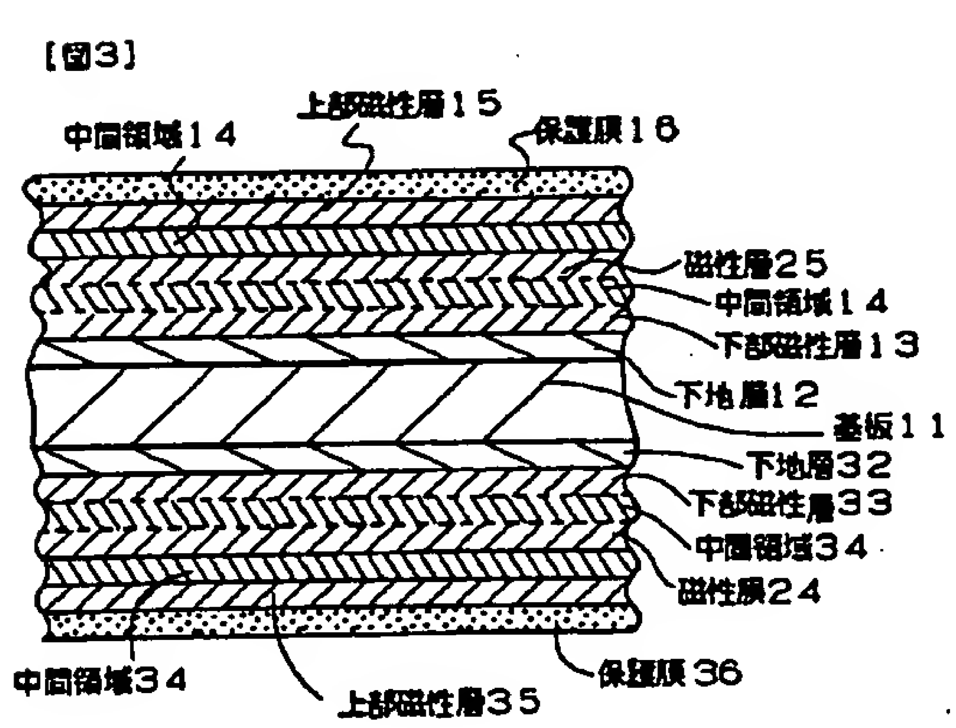
【図１】



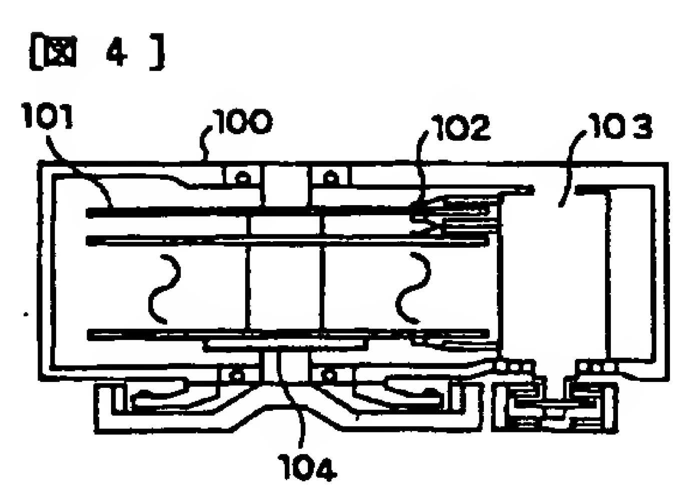
【図２】



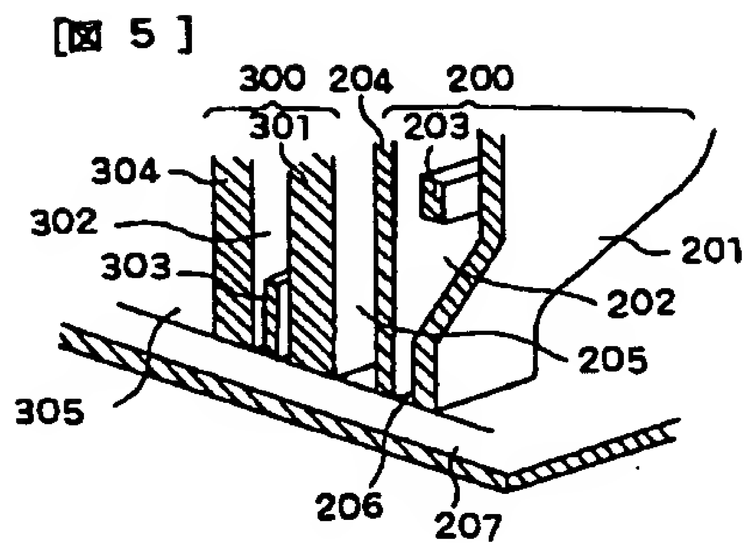
【図３】



【図４】



【図5】



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